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Technical Note: Composition of tomato processing wastes

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Fatty acid composition, mineral composition, sterols, tomato pomace, unsaponifiable matter.

Introduction

A major problem faced by the food industry is the accumulation, handling and disposal of processing wastes, and there is an increasing demand for their conversion into useful by-products.

Tomato pomace, a waste product from tomato processing plants, consisting of skins, pulp and seeds, was found to be useful as animal feed (Esselen & Fellers, 1939; Morrison, 1961; Ammermann *et al.*, 1963). The major component of tomato pomace is the seeds, which have been evaluated by several workers (Gad *et al.*, 1968; Tsatsaronis & Boskou, 1975; Kramer & Kwee, 1977b; Canella *et al.*, 1979), and found to contain 22.2–29.6% crude fat, 15.5–21.7% crude fibre, 5.4–9.6% ash and 22.9–33.9% crude protein; the latter has good functional and nutritional properties (Kramer & Kwee, 1977a,b; Canella & Castriotta, 1980; Latlief & Knorr, 1983). The oil has a high unsaturated acid content, with over 39% linoleic acid (Gad *et al.*, 1968; El-Tamimi *et al.*, 1979).

The aim of this study was to investigate the composition of Greek tomato processing wastes.

Materials and Methods

Samples of tomato pomace were obtained from tomato processing plants of the Argos region, sun dried, ground in a blender and the seeds and skin separated using a sieve system of 2.0 and 1.6 mm. Each was ground separately in a Brabender mill to pass through a 1.00 mm sieve.

Seed and skin oils were extracted with petroleum ether (boiling point 30–60°C, 24 hr) in a Soxhlet extractor, the solvent removed under reduced pressure and the oil stored in sealed glass bottles at 0–4°C.

Moisture, crude oil, crude protein (N×6.25), crude fibre and ash were analysed in seeds and skins, using AOAC (1975) procedures. Minerals (K, Ca, Mg, Fe, Cu, Zn, Mn, Ni and Cr) were determined by atomic absorption spectroscopy (Perkin-Elmer 2380) and phosphorus by a spectrophotometric method (AOAC, 1975), after dry ashing. Oils were analysed in triplicate for acidity, iodine value, saponification number and unsaponifiable matter by AOAC (1975) methods. Refractive index was determined by an Abbe refractometer with temperature adjustment. The unsaponifiable matter of

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tomato skin oil was separated using thin layer chromatography (TLC) (alumina G, 20×20 cm plates), developed in benzene:acetone (95:5). Identification was made by comparison of Rf values with standards.

Fatty acid composition was determined, as methyl esters, by gas-liquid chromatography (GC) according to AOAC (1975) procedures with 0.5 N methanolic NaOH and BF_3-MeOH. Gas chromatographic conditions were: helium carrier, 0.4 × 160 cm glass column, 5% Carbowax 20 M on Chromosorb W-AW 80/100 mesh, injector 180°C, flame ionization detector 300°C, column 70°C for 10 min and then 2°C/min to 230°C. Compounds were identified by peak retention times, and compared with those of methyl ester standards; identity was confirmed by gas chromatography-mass spectroscopy (GC-MS) (Hewlett-Packard 5980A, 5933A Data System; same column, injector 150°C, initial temperature 90°C, then 4°C/min to 230°C; ion source 170°C, 70 eV).

Unsaponifiable matter of tomato seed oil was analysed by TLC (silica gel, 20×20 cm plates, ethyl ether/petroleum ether (1:1), sprayed with dichlorofluorescein). The sterol bands were separated, extracted with ethyl ether, and the solvent evaporated under reduced pressure. Methyl acetate was added, and the sterols were analysed by GC (0.4×185 cm OV-17 glass column, 265°C, injector 280°C, detector 300°C, carrier gas helium). Cholesterol, campesterol, stigmasterol, and β-sitosterol were used as standards.

Results and Discussion

Table 1 shows the proximal composition of seeds and skins (dry basis). Oil and fibre contents of both seeds and skin are somewhat lower, and crude protein higher, than the medians of the ranges reported (Gad *et al.*, 1968; Tsatsaronis & Boskou, 1975; Canella

Table 1. Approximate composition of tomato seeds and skins (dry basis)

Assay	Value for: Seed	Skin
Moisture (%)	11.7	10.1
Crude oil (%)	22.4	1.7
Crude protein (N×6.25) (%)	32.6	20.0
Crude fibre (%)	14.6	46.1
Carbohydrates (by difference) (%)	25.4	26.6
Ash (%)	4.8	5.6
Minerals (mg/100 g)		
K	825.0	1270.0
Ca	163.4	217.4
Mg	119.7	121.7
Fe	27.3	60.9
Cu	2.0	1.7
Mn	5.5	2.7
Zn	9.0	10.2
Ni	*	*
Cr	*	*
P	660	125

*Below detection limit of the AAS instrument

& Castriotta, 1980; Latlief & Knorr, 1983). Both seed and skin are also good sources of minerals, especially K, Ca, Mg, Fe and P, although the values also differ from the results of Tsatsaronis & Boskou (1975). These differences may be caused by variations in cultivar or origin, or for protein in skin, by some minor contamination with seeds.

Oil characteristics are shown in Table 2. The seed oil was a red-yellowish liquid at ambient temperature with high iodine and saponification numbers characteristic of many seed oils (Swern, 1979). The skin oil was a brown-yellowish solid with a very high unsaponifiable content, with low iodine and saponification numbers. The composition of the seed oil confirms that found by El-Tamimi *et al.* (1979). The major fatty acid in both was linoleic (18 : 2), but the seed oil contained a much greater proportion of total unsaturated acids (80.9%) than the skin oil (63.1%). Thus tomato seed oil may be of some nutrient value, and it may also be classified as a semi-drying oil. The predominant saturated acid in both was palmitic (16 : 0).

The TLC analysis of the unsaponifiable matter of the skin oil showed the probable presence of xanthophylls, sterols, higher alcohols, and tocopherols.

The main sterol of the unsaponifiable matter of crude tomato seed oil was β-sitosterol (66.55% of the total sterols), followed by cholesterol, 21.20%. Stigmasterol (8.24%) and campesterol (3.84%) were also found, as well as a trace of Δ^5-avenasterol (0.07%). In addition a peak of an unknown sterol was detected at concentration of 0.10%. This component exhibited a relative retention time to cholesterol of 1.166. Yamamoto & Mackinney (1967) mentioned the existence of stigmasterol, β-sitosterol and possibly campesterol in tomato fruits and seeds. These above results are in good agreement with those reported by Chow & Jen (1978). Ismail, Shawki & Hamza (1978) have reported a total cholesterol concentration of 30.0 mg/100 g for the edible portion of tomatoes.

Table 2. Characteristics and fatty acid composition of crude tomato seed and skin oil

Assay	Value for: Seed	Skin
Oil characteristics		
Acidity (% as oleic)	3.2	—
Iodine value (Wijs)	105	77
Saponification number	190	133
Unsaponifiable matter (%)	1.3	20
Refractive index (n at 60°C)	1.4577	1.4684
Fatty acids (%)		
10:0	—	1.3
12:0	—	1.0
14:0	0.5	3.0
16:0	13.8	20.6
16:1	0.5	1.8
17:0	0.6	3..
18:0	3.4	4.7
18:1	21.4	16.3
18:2	55.0	42..
18:3	4.0	2.7
20:0	0.5	2.5

Tomato processing wastes are rich in nutrients and could be utilized successfully as a source of protein concentrates (seed proteins) and of edible oil for human consumption, as well as for feed. Crude fibre could be used as a source of dietary fibre.

Such a utilization of tomato processing wastes could provide extra income and at the same time reduce a waste disposal problem.

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